# Sub-glacial geology of Antarctica: A preliminary investigation and results in the Grove Mountains and the Vestfold Hills, East Antarctica and its tectonic implication

Y. Zhao, S.-H. Zhang, X.-C. Liu, J.-M. Hu, J. Liu, Y.-B. Pan, M.-J. An, and G. Xu

Institute of Geomechanics, Chinese Academy of Geological Sciences, 100081, Beijing, China (yuezhao@public3.bta.net.cn)

**Summary** In this paper we present our recent investigation and preliminary results of erratic rocks in the Grove Mountains and the Vestfold Hills to understand the sub-glacial geology of Antarctica. Thirteen high pressure mafic granulite erratic rocks from the Grove Mountains give peak metamorphism at 12.8-15.8 kb and 790-910°C around 545-542 Ma by a conventional thermometer and barometer with SHRIMP U-Pb zircon dating. It is the first report of a Pan-African high-pressure granulite facies record inland Antarctica, key evidence for a Pan-African suture beneath ice sheet near the Grove Mountains. Investigation and statistics of erratic rocks in the southeast Vestfold Hills show that low-grade rocks are in the majority at some localities. Analyses of the erratic rocks by ongoing zircon SHRIMP U-Pb dating and their Hf isotope as well as mineral Ar-Ar ages can enrich our knowledge of the sub-glacial geology of Antarctica, combined with glacier dynamics, sub-glacier morphology and geophysics.

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## Introduction

Antarctica is covered by ice. There are only about 2% bedrocks cropping out, most of which have been investigated. Our knowledge of the geology of Antarctica is based upon them and various tectonic models were drawn from them. However, we often face the fact that there is too little exposed rock to develop robust models of basement geological evolution. During International Polar Year, programs were launched to explore sub-glacial Antarctica, including AGAP program (Antarctica's Gamburtsev Province). AGAP will explore the origin, evolution and setting of the Gamburtsev sub-glacial highlands, a major IPY objective. To understand the sub-glacial geology of Antarctica, we present, in this contribution, our recent investigation and preliminary results of erratic rocks in the Grove Mountains and the Vestfold Hills.

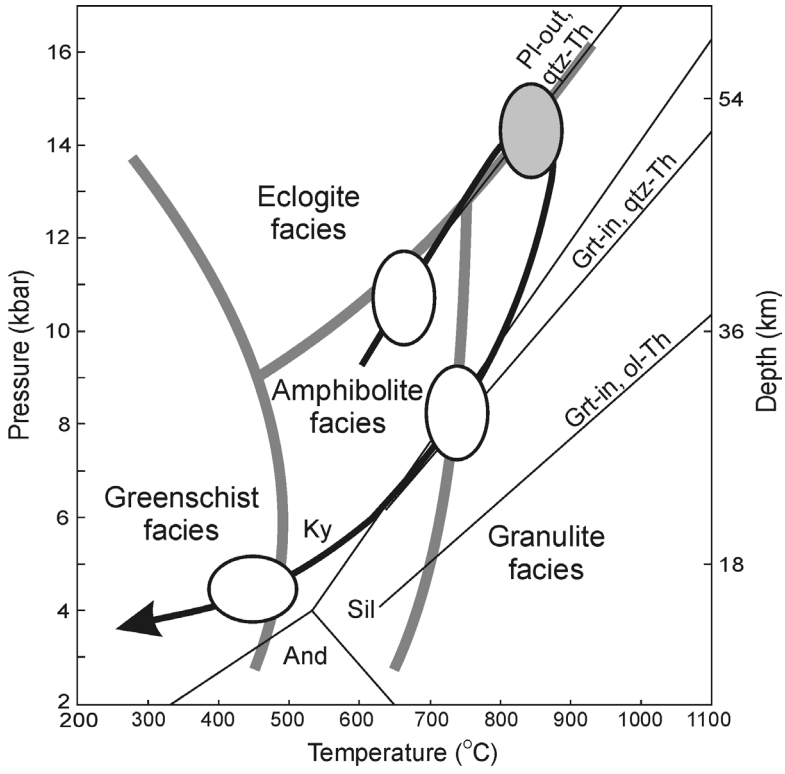


**Figure 1.** P-T path of high P mafic granulites from form the Grove Mts

## The Grove Mountains

The Grove Mountains, a high-grade terrane that underwent a single high-temperature granulite facies tectonic event around 530-550 Ma (Zhao et al., 2000; Liu et al., 2007), are the southern continuation of the Pan-African age Prydz belt, East Antarctica, although Boger et al. (2001) proposed that the Pan-African age southern Prince Charles Mountains (sPCMs)-Prydz Bay suture extends westwards through the Lambert Terrane, the southern Prince Charles Mountains to intersect with the East African Orogen somewhere in Dronning Maud Land. Direct evidence is still wanted for the assembly model to support collision between different Grenville-age blocks in East Antarctica (Fitzsimons, 2000) instead of


**Figure 2.** Glacial erratics of the southeastern Vestfold Hills(a) greenschist; (b) phyllite; (c) quartzite; and (d) slate

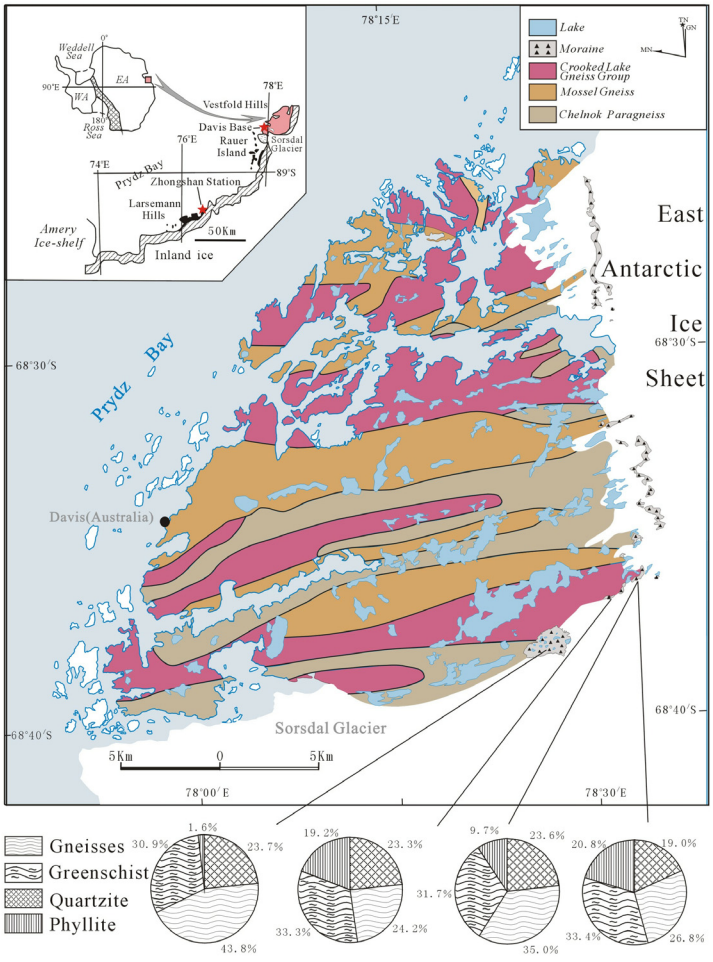


**Figure 3.** The geological map of the Vestfold Hills, East Antarctica

intra-continental activation, e.g., slices of ophiolite suite and/or high pressure metamorphism. But the chance to find them is unlikely due to limited outcrops in inland Antarctica.

To search for the suture zone inland Antarctica, we examined erratic rocks in morainal deposits and obtained 13 high pressure mafic granulite erratic rocks, which give peak metamorphism at 12.8-15.8 kb and 790-910°C (Fig. 1) around 545-542 Ma by a conventional thermometer and barometer with SHRIMP U-Pb zircon dating (Liu et al., in preparation). It is the first report of a Pan-African high-pressure granulite facies record inland Antarctica, which is key evidence for a Pan-African suture beneath ice sheet near the Grove Mountains in the upper reaches of ice flows.

## The Vestfold Hills

We investigated morainal deposits along the Dalk Glacier and Sorsdal Glacier, the eastern Prydz Bay coast, on which high-grade terranes, the Archean Vestfold Hills (Black et al., 1991), the composite Archean and Proterozoic Rauer Islands (Harley et al., 1998) and Proterozoic and the Cambrian Larsemann Hills (Dirks & Wilson., 1995; Carson et al., 1995) crop out. The Dalk Glacier is a clean one. We found no significant

morainal deposits there.

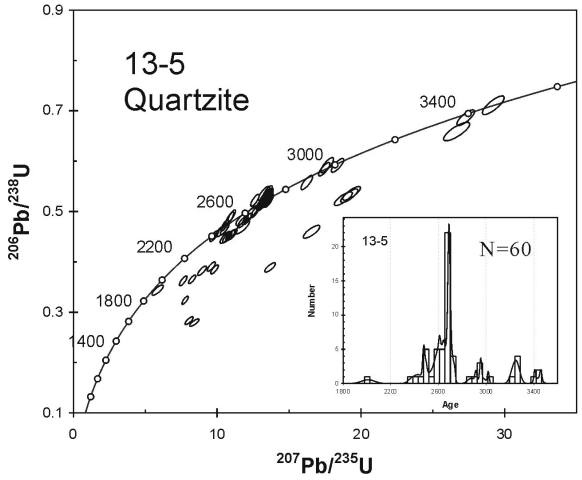


**Figure 4.** Zircon LA-ICP-MS U-Pb age plot for a quartzite within the glacial erratics from the Vestfold Hills

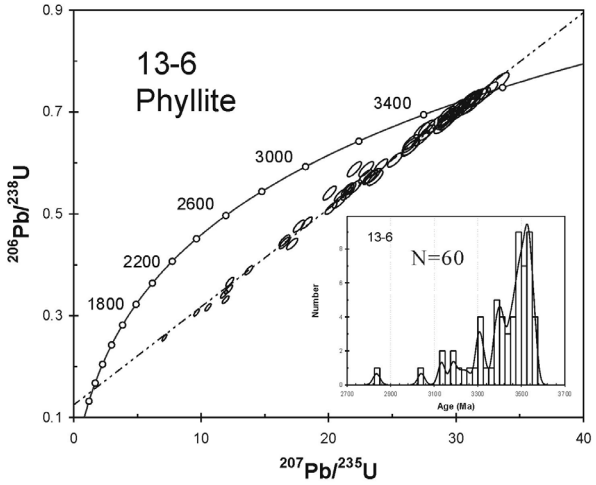


**Figure 5.** Zircon LA-ICP-MS U-Pb age plot for a phyllite sample within the glacial erratics from the Vestfold Hills

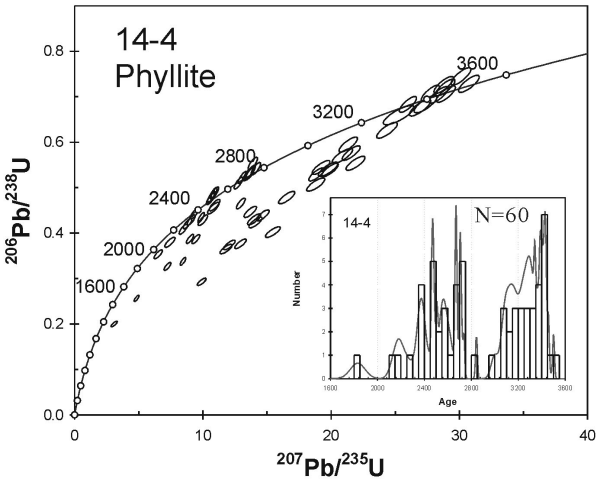


**Figure 6.** Zircon LA-ICP-MS U-Pb age plot for another phyllite sample within the glacial erratics from the Vestfold Hills

The glacier around the southeastern Vestfold Hills is a dirty one, leaving much more morainal deposits there. We can observe not only high-grade gneisses but also low-grade rocks, including greenschist, quartzite and phyllite (Fig. 2), which are much different from autochthonous rocks and are considered brought out beneath upper reaches of Antarctic ice sheet. We made statistics of erratic rocks at ten localities. At least four localities show that low-grade rocks are in the majority (Fig. 3). Preliminary LA-ICP-MS U-Pb results (Figs. 4-6) for zircon grains from erratic phyllites and quartzite show that most of them are Archean in age, inherited composition, which may be the provenances for the Archean gneisses of Rauer Is. Ongoing analyses of the gravel erratics by zircon LA-ICP-MS and SHRIMP U-Pb dating and their Hf isotope as well as mineral Ar-Ar ages can enrich our knowledge of the sub-glacial geology of Antarctica, which will be combined with glacier dynamics, sub-glacier morphology and geophysics.

## Summary

The investigation and preliminary results of erratic rocks in the Grove Mountains and the Vestfold Hills support the model that probably there is a Pan-African suture beneath ice sheet approximately along the Prydz belt, which enriches our knowledge of the sub-glacial geology beneath upper reaches of Antarctic ice sheet to the Grove Mountains and the Vestfold Hills.

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